IV.4 GEOLOGY AND SOILS

IV.4.1 Approach to Impact Analysis

This chapter addresses the potential impacts on geologic and soil resources from implementing the Bureau of Land Management (BLM) Land Use Plan Amendment (LUPA) for the Desert Renewable Energy Conservation Plan (DRECP) alternatives. This analysis is based on the description in Volume II of the Proposed LUPA, including actions associated with renewable energy development that would be permitted within Development Focus Areas (DFAs).

This chapter provides an analysis of impacts from geologic hazards and problematic soils; Volume III, Chapter III.4 describes existing conditions for geologic hazards and soil resources. Three tables supporting this chapter appear in Appendix R2.4. These tables present the acreage of soil texture, erosive soils, and expansive soils within DFAs for each alternative.

Specific impacts of renewable energy facility development would depend on a variety of factors, including project location within the DFAs, type and scale of technology, the size of the development, and site-specific soil conditions. Due to the uncertainty of specific locations for development within the DFAs, this impact analysis is based on the total acreage of land that could be affected.

This analysis of impacts on geology and soils assumes that:

- Soil resources within BLM-administered lands will be managed to meet standards in the Rangeland Health Standards and Guidelines for California and Northwestern Nevada.
- Substantial surface disturbance to soil—including exposure of bare ground, loss of vegetation and soil biotic crusts, and rutting on unsurfaced roads—would increase soil compaction, water runoff, and downstream sediment loads. It would also lower soil productivity and increase fugitive dust emissions, degrading water and air quality, altering channel structure, and affecting overall watershed health, air quality, and potentially human health.
- Several factors would influence the degree of impact to any one disturbance or series of disturbances, including the disturbance's location within the watershed, the time and degree of the disturbance, existing vegetation, and levels of precipitation at the time of the disturbance.
- Any access roads would follow the design standards of the BLM Roads Design Handbook H-9113-1 or the higher standard required by the State of California to protect air or water quality.

- Surface soil stockpiles would be set aside for future restoration after grading or excavation.
- Design features and management practices identified in the Best Management Practices and Guidance Manual for Renewable Energy Development (California Energy Commission [CEC] 2010]) would be followed for site-specific projects.

The DRECP Environmental Impact Statement (EIS) and LUPA are programmatic documents; the analysis is therefore primarily for typical impacts and does not evaluate site-specific impacts from specific projects. Project-specific impacts would instead be assessed during the permitting process and in supplemental National Environmental Policy Act (NEPA) or joint NEPA/California Environmental Quality Act (CEQA) documents (for projects under CEC jurisdiction). Because the specific locations of future renewable energy projects are still undetermined, this impact analysis presents information on faults and problematic soils within DFAs, Variance Process Lands, and BLM LUPA conservation designations.

IV.4.2 Typical Impacts Common to All Action Alternatives

The potential effects of renewable energy development (solar, wind, geothermal and transmission) upon geology and soils are evaluated through review of completed CEQA and NEPA documents, the Solar Programmatic Environmental Impact Statement (Solar PEIS), the Wind PEIS, and the Geothermal PEIS. Existing conditions for geology and soils are described in Chapter III.4.

This section analyzes the typical direct and indirect impacts of solar, wind, and geothermal projects and transmission lines. Approval of a LUPA alternative would facilitate the development of renewable energy projects within defined DFAs by streamlining both permitting decisions and mitigation actions for protected species. Each future project would undergo required NEPA and/or CEQA analysis, but information in this EIS could prove useful for document preparation. Impacts related to renewable energy projects and transmission would vary depending upon the technology proposed, the location of the project area, the time and degree of disturbance from development, and the size and complexity of the facility.

LUPA components could have indirect impacts on geologic features including important scenic and structural geologic features and seismic risk; seismic activity and other geologic hazards may have indirect impacts on projects. LUPA alternatives could also cause indirect impacts on soils, particularly sensitive soils. The alteration or removal of vegetative cover could require more and wider roads or cause surface disturbances in areas with high wind or water erosion. Other project activities could damage soil surface covers like desert pavement or biological soil crusts.

Because LUPA land designations would be managed to protect ecological, historic, cultural, scenic, scientific, and recreation resources and values, they would also provide general protection for geologic and soil resources. While other land uses are allowed within these areas, those uses must be compatible with the resources and values that the land designation is intended to protect.

Guidelines for the allowable uses and management of National Conservation Lands, lands with wilderness characteristics, and trail management corridors appear in the LUPA description in Volume II. Details on the goals, objectives, allowable uses, and management actions for each Area of Critical Environmental Concern (ACEC) and Special Recreation Management Area (SRMA) appear in LUPA worksheets in Appendix H.

IV.4.2.1 Impacts of Renewable Energy and Transmission Development

This analysis considers a wide range of potential geologic impacts from renewable energy development and transmission. Impacts include soil erosion, disturbance of desert pavement, and potential effects of geologic hazards including active faults, potentially active volcanoes, landslides and mudslides, and the impacts of expansive or corrosive soils over the lifetime of renewable energy projects. Each of these impacts is discussed in the following sections.

IV.4.2.1.1 Impacts of Site Characterization

Site characterization for renewable energy projects includes land surveying; biological, cultural and paleontological surveys; and geotechnical studies. These activities create ground disturbances with a range of impacts. Land surveying and biological, cultural, and paleontological surveying are low-impact activities. Geotechnical studies have low to moderate impact, depending upon specific site environments. Impacts from site characterization also include increased soil erosion and the potential disturbance of desert pavement.

IV.4.2.1.2 Impacts of Construction and Decommissioning

Soil erosion. Soil erodibility is determined primarily by soil texture. Soils with high silt content erode more readily than soils with high clay content. Weathering happens when wind or water gradually break rocks down (e.g., when water freezes within the cracks of rocks then expands the rocks to the point of fracture). Weathered soils are more susceptible to erosion because they have smaller particles, but a wide range of soil particle size is susceptible to erosion, depending on the strength of the wind or water flows. Portions of the desert contain soils with a moderate to high potential for erosion from wind and water.

During project construction and decommissioning excavation, grading, construction activities, and watering for dust control could all contribute to soil erosion. If blasting is required during excavation, it could also disturb the soil and increase erosion. In addition, without effective best management practices (BMPs), storms could increase erosion during both construction and decommissioning.

Desert pavement. As stated in Volume III, Section III.4.2, about 60% of the surficial geologic formations within the DRECP area are alluvium (material deposited by moving water). Over time, alluvium can form a protective surface crust of pebbles called desert pavement. The disturbance of desert pavement would substantially increase surface erosion from wind and water and create dust hazards. These surficial deposits are valuable because the natural regeneration of desert pavement is very slow in the Mojave Desert. Excavation, grading, and ground disturbance from workers, vehicles, and equipment would damage existing desert pavement.

Sand Transport. Sand transport corridors are zones where windblown sands move across the desert. They are important because they create valuable habitat for sensitive biological resources. Development of renewable energy projects in some parts of the desert, including the Eastern Riverside County region, would be in or near important sand transport corridors. The sand transport corridor in the eastern portion of Riverside County runs parallel to Interstate 10 (I-10) in Riverside County between Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor (including the Kelso Dunes), Bristol Trough corridor (including the Cadiz and Danby dunes), Rice Valley corridor (including the Rice Valley Dunes), and Clark's Pass corridor (including the Dale Lake Dunes and Ford-Palen Dunes) (U.S. Geological Survey [USGS] 2003).

Renewable energy projects in these regions could interrupt sand transport and consequently affect valuable habitat within corridors containing active sand dunes. Conversely, sand transport could also damage renewable energy facilities and hinder energy production. Large areas of dune systems and sand transport corridors are located in the central and southern portions of the DRECP area. Approximately 1,781,000 acres of dune systems and sand transport corridors exist in the entire DRECP area (Data Basin 2014[a]). The highest concentrations of dune systems and sand transport corridors in the DRECP area are:

- 841,000 acres in the eastern part of Riverside County.
- 245,000 acres in the Imperial Valley region.
- 205,000 acres in the Central Mojave region.

See Chapter III.4, Figure III.4-2, Dune Systems and Sand Transport Corridors within the DRECP Area, Section III.4.2.2.1.1.

IV.4.2.1.3 Impacts of Operations and Maintenance

Seismic, volcanic, or landslide activity. Based upon the number and length of active faults described in Section III.4.3, the southern California desert is seismically active. Some of the longest and most active faults in the state pass through the desert, including the San Andreas Fault. See Figure III.4-4, Earthquake Faults within the DRECP Area and Table III.4-2, Largest Faults Within the DRECP Area, for the specific locations and strengths of faults in the DRECP area. Seismic activity is likely in areas both around and west of the San Andreas and Superstition Hills faults. Major earthquakes like the Landers Earthquake of 1992 (Richter magnitude 7.3), will continue to strike, causing property damage. See Table III.4-3 (in Section III.4.4, Earthquakes Within the DRECP Area With a Magnitude 6.0 or Higher. Based on project location, future earthquakes could damage renewable energy facilities and transmission lines.

Volcanic activity is of greatest concern in areas of recent eruptions. Younger volcanic flows exist in the Salton Buttes in the Imperial Borrego Valley ecoregion subarea (see Appendix R1, Table R1.4-1, Regional Geology in the DRECP Area), in areas east of Barstow near the Pisgah Crater, and in southern Inyo County. However, the low likelihood that renewable energy facilities would be located in the immediate area of an active volcanic site means that volcanic activity is not likely to affect renewable energy development.

Geothermal resources would more likely be sited in areas with volcanic activity. These resources have been identified in Imperial County, as well as in the Coso and Randsburg areas of Inyo and San Bernardino counties.

Solar facilities are not generally built on steep slopes where landslides are most likely. It is therefore unlikely that landslides would damage solar projects. Before site design and construction, site-specific geotechnical investigations would be required to ensure that landslide hazards to wind turbines would be minimal during project operations and maintenance.

Expansive soils. Expansive soils have a high clay content, which has a greater ability to shrink and swell with changes in soil moisture content. This includes soils with clay, silty clay, and clay loam textures. As these soils expand and contract, they could damage structural and operational elements of renewable energy facilities. Nearly 589,000 acres of expansive soils are within the DRECP area.

The highest concentrations of expansive soils within the DRECP area are:

- 156,000 acres in the Death Valley area.

- 89,000 acres in the eastern end of Riverside County.
- 69,000 acres in the Owens River Valley.

For further details on soil texture by ecoregion subarea, see Appendix R1, Figures R1.4-1 through R1.4-10.

Corrosive Soils. As stated in Section III.4.2.2.2, mild to aggressive soil corrosivity within the DRECP area could corrode ungalvanized steel and concrete. Soil corrosion could create hazards that could potentially undermine the long-term integrity of renewable energy infrastructure, including damage to foundations and other parts of structures over the lifetime of the renewable energy projects.

Vegetation in the desert is specifically adapted to its native soil characteristics. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially damaging corrosive soil. Approximately 509,000 acres of these soils are within the DRECP area (Data Basin 2014[b]). The highest concentrations of potentially corrosive soils are:

- 133,000 acres in the Death Valley portion of the DRECP area.
- 117,000 acres in the Central Mojave portion of the DRECP area.
- 63,000 acres in the Lucerne Valley portion of the DRECP area.
- 55,000 acres in the West Mojave portion of the DRECP area.
- 28,000 acres in the Owens Valley portion of the DRECP area.

For further information on corrosive soils within the DRECP area, see Section III.4.2.2.2, Corrosive Soils, and Figure III.4-3, Potentially Corrosive Soils Within the DRECP Area.

IV.4.2.2 Impacts of the Ecological and Cultural Conservation and Recreation Designations

Lands within conservation areas are protected from development, so renewable energy projects would not be built in those areas.

IV.4.3 Impact Analysis by Alternative

The following sections present impact analyses for the No Action Alternative, the Preferred Alternative, and Alternatives 1 through 4.

IV.4.3.1 No Action Alternative

The No Action Alternative assumes that renewable energy, transmission development, and mitigation for projects in the DRECP area would occur on a project-by-project basis and in a pattern consistent with past and present renewable energy and transmission projects. The No Action Alternative identifies approximately 2,804,000 available acres for renewable energy development. The No Action Alternative does not include new BLM LUPA conservation designations, though existing conservation comprises approximately 7.6 million acres of the DRECP area in all alternatives.

IV.4.3.1.1 Impacts of Renewable Energy and Transmission Development

Available developable areas in the No Action Alternative are concentrated on BLM land in the Tehachapi Mountains, West Mojave, Imperial Valley, Eastern Riverside County, and Kingston and Funeral Mountains regions of the DRECP area. Impacts to soils, geology, and geologic hazards would result from the development of solar, wind, and geothermal projects. There would also be impacts from transmission development.

The potential for increased soil erosion is quantified by the acreage of erosive soils that may be disturbed during construction and decommissioning and, to a lesser degree, during site characterization. The potential for impacts from geologic hazards is based on miles of active fault lines within 25 miles of developable areas under the No Action Alternative. Other geology and soil impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed more qualitatively.

In general, under the No Action Alternative, existing BLM land management plans within the LUPA Decision Area would continue. Existing ACECs and wildlife allocation areas would continue to limit adverse impacts to geology and soils because only projects consistent with those areas' goals and objectives would be allowed. Existing SRMAs would continue to experience potentially adverse effects from soil erosion, depending upon the extent of allowable uses and management practices within specific SRMAs.

Under the No Action Alternative, development would continue on certain BLM lands including Solar Energy Zones, Solar PEIS Variance Lands, and with a project-specific LUPA.

Impact SG-1: Expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, such as the San Andreas and San Jacinto fault systems. During the lifetime of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-1 shows major active faults, defined by the USGS as having ruptured within the Holocene (the past 11,000 years) (USGS 2014[a]).

For each fault, Table IV.4-1 shows both its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. Under the No Action Alternative, 86.6 miles of active fault lines are within developable areas and 798.7 miles are outside developable areas but within the 25-mile buffer set for the fault analysis. See Volume III, Table III.4-2, Largest Faults Within the DRECP Area, for the earthquake magnitude potential for each of the listed faults and their associated Alquist-Priolo designations. The faults presented in Table IV.4-1 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied structures, damage to property could still be considerable.

Table IV.4-1
Faults Within a 25-Mile Radius of Developable Areas in the No Action Alternative

Fault Name	Length of Fault Within Developable Area (miles)	Length of Fault Outside Developable Areas (miles)
Blackwater Fault	0.3	13.0
Bullion Fault		20.4
Calico Fault Zone	3.8	25.6
Coyote Creek Fault	3.7	29.0
Death Valley Fault Zone		59.1
Elsinore Fault Zone	1.7	31.1
Emerson Fault	2.3	28.0
Furnace Creek Fault Zone		6.4
Garlock Fault Zone	21.6	118.3
Gravel Hills - Harper Fault Zone	2.7	23.5
Helendale Fault	14.7	16.1
Johnson Valley Fault	4.6	33.0
Laguna Salada Fault Zone	3.3	16.4
Lenwood Fault	22.6	21.5
Lockhart Fault	2.1	1.8
Mill Creek Fault		22.9
Pinto Mountain Fault	0.1	31.8
San Andreas Fault Zone	3.1	139.6
San Bernardino Fault		31.7
San Cayetano Fault		1.1
San Jacinto Fault Zone		85.3
Santa Susana Fault Zone		0.7
West Calico Fault		21.0

Table IV.4-1
Faults Within a 25-Mile Radius of Developable Areas in the No Action Alternative

Fault Name	Length of Fault Within Developable Area (miles)	Length of Fault Outside Developable Areas (miles)
White Wolf Fault		21.4
Grand Total	**86.6**	**798.7**

Volume III, Section III.4.4.4, describes locations of recent volcanic activity. Within available development areas in the No Action Alternative, there is minimal acreage of recent volcanic flow rocks. The likelihood of a renewable energy facility being located near an active volcanic site is low because both developers and regulators would avoid areas with this risk. Facility damage or threat to life from volcanic activity is possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative, (Appendix R2) shows the erosion potential of soil textures found in the DRECP area and the acreages of soil textures with erosion potential in the DFAs, for each alternative. On developable BLM-administered lands in the No Action Alternative, there are approximately 1,451,000 acres of soils with a moderate to high potential for wind erosion and approximately 795,000 acres of soils with a moderate to high potential for water erosion. Development of renewable energy facilities within these areas in the No Action Alternative would increase the likelihood of soil erosion from wind and water.

Sand Transport. Under the No Action Alternative, developable areas in the Eastern Riverside County region are on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between the areas of Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor, which includes the Kelso Dunes, the Bristol Trough corridor, which includes the Cadiz and Danby dunes, the Rice Valley corridor, which includes the Rice Valley Dunes, and the Clark's Pass corridor, which includes the Dale Lake Dunes and Palen-Ford Dunes (USGS 2003). Renewable energy facilities in these developable areas could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Approximately 307,000 acres of dune systems and sand transport corridors are within developable areas in the No Action Alternative.

While existing management plans do not establish specific goals for soil resources, BLM uses standard best management practices (BMPs) to protect soil resources. Among the reference guides listing these BMPs is the BLM publication *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development*, commonly referred to as the Gold

Book, last updated in 2007. Under the No Action Alternative, BLM's management of geology and soil resources through these standard BMPs, as well as mitigation imposed as a result of NEPA review, would reduce adverse impacts during construction.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2.1.3, Impacts of Operations and Maintenance, corrosive soils could damage foundations and structural elements of renewable energy facilities. Expansive soils could cause soils to shrink or swell, damaging foundations and other structural elements. The No Action Alternative includes 70,000 acres of potentially expansive soils. See Table R2.4-3, Acreage of Expansive Soil Textures Within DFAs for Each Alternative (Appendix R2). Expansive soils include clay, clay loam, silty clay, and silty clay loam. Corrosive soils are widespread throughout the DRECP area. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate the presence of potentially corrosive soil. Approximately 36,000 acres of potentially corrosive soils are within developable areas in the No Action Alternative.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities in the No Action Alternative may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

Impact Reduction Strategies

Laws and Regulations

Existing laws and regulations would reduce the impacts of renewable energy projects in the absence of the DRECP. Relevant regulations are presented in the Regulatory Setting in Volume III. Note that because this EIS addresses amendments to BLM's land use plans, these plans are addressed separately and are not included in this section.

Mechanisms in relevant regulations would reduce impacts as follows:

- The Clean Water Act of 1972 requires operators of construction sites that disturb one acre or more to obtain a permit under the National Pollutant Discharge Elimination System's (NPDES) general permit entitled Stormwater Discharges Associated With Construction Activity. Stormwater runoff from construction activities can significantly affect water quality. This permit requires preparation of a Stormwater Pollution Prevention Plan, which must include a site description; a map that identifies sources of stormwater discharges on the site; anticipated drainage patterns after major grading; areas where structural and nonstructural measures will be employed; surface waters, including wetlands; and locations of discharge points to surface waters.

- The California Building Code (CBC) Section 1613.3.5 (CBC 2013) requires all new construction to follow earthquake design guidelines by completing a geotechnical investigation for all buildings in Seismic Design Categories C, D, E, and F. The majority of the DRECP area is made up of categories C, D, and E, which are based on the following three criteria:
  1. Probable site ground motion – Probable site motion is based on Federal Emergency Management Agency (FEMA) maps, the maximum acceleration of an object in an earthquake, and a structure's response to wave acceleration. See Volume III, Figure III.4-13, Peak Horizontal Ground Acceleration Within the DRECP Area.
  2. Soil site classifications – Soil classifications A through F include hard rock, rock, dense soil, stiff soil, soft soil, and special soils.
  3. Building occupancy type – Building occupancy contains four types: agricultural, essential, hazardous structures in the event of a collapse, and "other."
- In addition, Appendix J of the CBC requires that developers obtain county grading permits that would contain requirements for the appropriate management of on-site drainage and erosion control.
- The Alquist-Priolo Earthquake Fault Zoning Act (1972) prohibits permitting of buildings used for human occupancy where construction is across active faults.

In addition, the Solar PEIS includes numerous design features that would reduce the impacts of solar energy development on geology and soil resources (full text of all design features is shown in Appendix W). Relevant design features include the following:

- SR1-1 would minimize soil erosion and geologic hazards by identifying local factors that would cause slope instability or on-site soil erosion as well as geologic hazard concerns in proximity to the proposed project.
- SR2-1 would minimize soil erosion and sediment transport during all project phases. It requires minimal ground disturbing activities, culverts to control runoff to minimize erosion, and project siting to avoid disturbing desert pavement and areas with unstable slopes and soils. Construction grading must comply with requirements in CBC 2013. It also requires soil testing that complies with American Society for Testing and Materials standards, studies to determine the effects from

construction on sand transport corridors, and replanting project areas with native vegetation to reduce exposed soil through wind and water erosion.

- SR3-1 requirements would prevent erosion and geologic hazard design elements during operations and maintenance by requiring permanent barriers around washes and wetlands to control erosion; maintaining catch basins, roadway ditches, and culverts; and performing routine site inspections to monitor the effectiveness of erosion and sediment control measures.
- SR4-2 would restore the original grade and drainage patterns on a project site during reclamation and decommissioning.
- SR4-3 would restore a site's natural vegetation patterns and prevent future erosion and sedimentation by seeding and transplanting native plant communities during reclamation and decommissioning.
- WR1-1 would control project site drainage, erosion, and sedimentation through hydrologic analysis and modeling that would identify 100-year 24-hour rainfall events and calculate projected runoff; this would comply with NPDES requirements, manage runoff from impervious surfaces, create or improve landscaping for capturing runoff, and demonstrate that a project will not increase the risk of flooding.

Typical Mitigation Measures

Under the No Action Alternative, individual projects would continue to be reviewed and approved with mitigation measures adopted by BLM. Mitigation for geology and soils generally includes the following:

- **Protect disturbed soil from wind erosion during project construction.** Prior to receiving a construction permit, the applicant shall submit to the lead agency, for review and approval, a sedimentation and erosion control plan that identifies how disturbed surface soils will be stabilized to prevent wind erosion during construction and immediately after construction until revegetation begins. Wind erosion control measures include, but are not limited to, the use of mulch, soil stabilizers, and temporary revegetation (all compatible with special status species). This sedimentation and erosion control plan may also include standard provisions for dust control with water trucks or the periodic application of soil stabilizers.
- **Reduce effects of ground shaking.** Prior to issuance of construction permits, the design-level geotechnical investigations the applicant performs shall include site-specific seismic analyses to evaluate ground accelerations for the design of project components. Based on these findings, project structure designs shall be modified as deemed appropriate by the project engineer if anticipated seismic forces are found to be greater than standard design load stresses on project structures. Study results

and proposed design modifications shall be submitted to the lead agency for review before final project design and issuance of a construction permit.

- **Protect desert pavement.** Grading for new access roads or work areas in areas covered by desert pavement shall be avoided or minimized. If avoidance of these areas is not possible, the desert pavement surface shall be protected from damage or disturbance from construction vehicles temporary surface mats. A plan to identify and avoid damaging sensitive desert pavement shall be prepared and submitted to the lead agency for review and approval prior to construction. This plan shall include:
  - Defining all locations of surface disturbance including new access roads and grading locations.
  - Developing specific measures to protect desert pavement from damage or disturbance by using temporary mats.
  - Applying a nontoxic soil stabilizer before project operation. The applicant shall develop, for review and approval by the lead agency, a plan that outlines the frequency of nontoxic soil stabilizer applications, based on the specifications of the selected soil stabilizer.
  - Evaluating the potential for replacement of desert pavement with a similar gravel-sized layer where required.
- **Conduct landslide surveys and protect against slope instability.** A landslide survey of any steep hillside areas shall be conducted in and adjacent to areas of planned project construction. The survey will identify areas with the potential for unstable slopes, landslides, earth flows, debris flows, and seismically induced slope failure. If the results of the landslide survey indicate that slopes could likely fail and damage these structures, appropriate support and protection measures shall be designed and implemented to minimize potential damage. These design measures may include, but are not limited to, retaining walls, re-engineered slopes, removal of potentially unstable materials, and avoidance of areas below highly unstable areas. Study results and proposed design modifications shall be submitted to the lead agency for review before final project design and issuance of construction permits.
- **Conduct geotechnical studies to assess problem soil characteristics.** Prior to issuance of construction permits, these design-level geotechnical studies by the applicant shall identify the presence, if any, of potentially detrimental soil chemicals such as chlorides and sulfates. Appropriate design measures for protection of reinforcement, concrete, and metal-structural foundation components against corrosion shall be used, such as corrosion-resistant materials and coatings, thicker components for projects exposed to potentially corrosive conditions, and passive or

active cathodic protection systems. The geotechnical studies shall also identify areas with potentially expansive or collapsible soils and include appropriate design features, including the excavation of potentially expansive or collapsible soils during construction and replacement with engineered backfill, ground-treatment processes, and redirection of surface water and drainage away from expansive foundation soils. Studies shall conform to industry standards and American Society for Testing and Materials standards for field and laboratory testing. Study results and proposed solutions shall be submitted to the lead agency for review and approval prior to construction permit issuance.

- **Protect sand and sand transport corridors.** To mitigate loss of sand transport corridors, the project owner shall provide compensatory mitigation that may include compensation for lands purchased in fee title or in easement, in whole or in part, in the following ratios:
  - 3:1 mitigation for direct impacts on stabilized and partially stabilized sand dunes
  - 1:1 mitigation for direct impacts on non-dune Mojave fringe-toed lizard habitat
  - 0.5:1 mitigation for indirect impacts on stabilized and partially stabilized sand dunes

  If compensation lands are acquired, the project owner shall provide funding for the acquisition in fee title or in easement, initial habitat improvements, and long-term maintenance and management of the compensation lands. The compensation lands must include, at a minimum, the number of acres of stabilized and partially stabilized sand dune habitat defined by the lead agency.

  Compensation lands selected for acquisition shall provide suitable habitat for any sand-dependent species. Compensation lands must:
  - Be located within the bounds of the sand transport corridor from which habitat was lost.
  - Build linkages between known populations of sand-dependent species.
  - Be near larger blocks of lands either already protected or planned for protection, or which could be protected long-term by a public resource agency or a nongovernmental organization dedicated to habitat preservation.
  - Not have a history of intensive recreational use or other disturbance that might make habitat recovery and restoration unworkable.
  - Not be characterized by high densities of invasive species, either on or immediately adjacent to parcels that might jeopardize habitat recovery and restoration.

  - Not contain hazardous wastes that cannot be removed to make a site suitable for habitat.
  - Include water and mineral rights as part of the acquisition.
  - Be on land where long-term management is practicable.
- **Security for Implementation of Mitigation:** The project owner shall provide financial assurances to the lead agency that guarantee an adequate level of funding is available to implement the acquisitions and enhance sand-dependent species habitat, as described in this mitigation measure.
- **Preparation of Management Plan:** The project owner shall submit to the lead agency a Management Plan that reflects site-specific enhancement measures for sand-dependent species habitat on acquired compensation lands. The objective of the Management Plan shall be to enhance the value of the compensation lands and may include actions such as weed control, fencing to keep out livestock, erosion control, or protection of sand sources or sand transport corridors.

IV.4.3.1.2 Impacts from Ecological and Cultural Conservation and Recreation Designations

The No Action Alternative has no new conservation designations, but even without approval of one of the action alternatives existing LLPAs, including wilderness areas, would be protected from development. Under the No Action Alternative, renewable energy projects would still be evaluated and approved with project-specific mitigation requirements.

IV.4.3.1.3 Impacts of Transmission Outside the DRECP Area

Outside of the DRECP area, additional transmission lines would be needed to deliver renewable energy to load centers (areas of high demand). It is assumed that new transmission lines outside of the DRECP area would use existing transmission corridors and substations in the more populated coastal areas of the state. Locations outside of the DRECP area where new transmission lines might be constructed are in San Diego, Los Angeles, North Palm Springs–Riverside, and the Central Valley. These areas and their associated geology and soils are described in Volume III, Section III.4.8.

Impact SG-1: Plan components would expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

Active fault lines are located both near and across transmission corridors. Transmission tower failure could expose people or structures to injury or damage from seismic activity or landslides; service interruptions could also result. However, the risk of earthquakes and landslides is considered during site evaluations and in specifications for tower and span designs.

Impact SG-2: Soil or sand erosion would be triggered or accelerated due to plan components.

Transmission tower construction requires earthwork to establish construction areas, tower footings, and site access. Soil disturbed in the process could erode, with the greatest risk being on slopes. Except where corridors pass through the Tehachapi and San Gabriel mountains, transmission corridors outside the DRECP area are in relatively flat terrain. Soil susceptibility to erosion varies by soil type, slope, and vegetative cover. To control erosion, transmission line developers would be required to prepare and implement stormwater pollution prevention plans, which would include erosion control and site restoration. Because of their spacing and relatively narrow profile, transmission towers would not impede natural sand transport.

Impact SG-3: Plan components would expose structures to damage from corrosive or expansive soils.

Corrosive soils could damage tower foundations and expansive soils could cause soils to shrink or swell; both could damage structure foundations. Typical foundation installation involves excavating or boring and installing reinforced steel bar cages and encasing them in concrete. Where soil conditions could potentially damage footings, the excavation is oversized and backfilled with suitable material that will not either corrode or damage footings.

Impact SG-4: Plan components would destroy or disturb desert pavement.

Renewable energy facilities in the Preferred Alternative may cause damage to desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would cause damage or disturbance to this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

IV.4.3.2 Preferred Alternative

IV.4.3.2.1 Impacts of Renewable Energy and Transmission Development

Under the Preferred Alternative, activities associated with solar, wind, and geothermal development and operation would be permitted within DFAs. The Preferred Alternative includes 388,000 acres of DFAs, approximately 7.6 million acres of existing conservation within the DRECP area, and approximately 4.9 million acres of BLM LUPA conservation designations.

In the Preferred Alternative, dispersed solar development is anticipated in the West Mojave and Eastern Slopes ecoregion subarea, the Cadiz Valley and Chocolate Mountains ecoregion subarea, and the Imperial Borrego Valley ecoregion subarea. Dispersed wind development is anticipated in the West Mojave and Eastern Slopes ecoregion subarea, the Pinto Lucerne Valley and Eastern Slopes ecoregion subarea, and the Cadiz Valley and Chocolate Mountains ecoregion subarea. Dispersed geothermal development is anticipated in the Imperial Borrego Valley and the Owens River Valley ecoregion subareas.

Under the Preferred Alternative, DFAs are located primarily in the Imperial Borrego Valley ecoregion subarea, the Cadiz Valley and Chocolate Mountains ecoregion subarea, the West Mojave and Eastern Slopes ecoregion subarea, and the Panamint Death Valley ecoregion subarea. Impacts to soils, geology, and geologic hazards would occur within the DRECP area from the development of solar, wind, geothermal, and transmission facilities, both within and outside of DFAs.

Soil erosion potential can be quantified based on acreage of erosive soils that may be disturbed during construction and decommissioning and, to a lesser degree, during site characterization. The potential for impacts from geologic hazards can be quantified based on miles of active fault lines within 25 miles of DFAs in the Preferred Alternative. Other geology and soil impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed qualitatively.

The Proposed BLM LUPA conservation designations (e.g., National Conservation Lands, ACECs, wildlife allocations, lands with wilderness characteristics, and trail management corridors) would limit renewable energy development and be managed to protect various ecological, historic, cultural, scenic, and scientific resources and values, which would also provide general protection for geologic and soil resources. Disturbance caps on National Conservation Lands and ACECs would provide further protections. National Conservation Lands would make up the majority of proposed BLM land designations under the Preferred Alternative.

Existing or expanded SRMAs would also prohibit surface-occupying renewable energy development, but could conversely still cause soil erosion from recreation, depending upon the extent of allowable uses and management within specific SRMAs.

Impact SG-1: Expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active, with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, including the San Andreas and San Jacinto faults. During the lifetime of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-2, Faults Within a 25-mile Radius of

DFAs, in the Preferred Alternative, shows major active faults, which the USGS defines as having ruptured within the Holocene (the past 11,000 years) (USGS 2014[a]).

For each listed fault, Table IV.4-2 shows its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. Under the Preferred Alternative, 7.6 miles of active fault lines are within DFAs and 766.4 miles are outside DFAs but within the 25-mile buffer set for the fault analysis. See Volume III, Table III.4-2, Largest Faults Within the DRECP Area, for the earthquake magnitude potential for each of the listed faults and their associated Alquist-Priolo designations. The faults presented in Table IV.4-2 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied residential structures, damage to property could still be considerable.

Table IV.4-2
Faults Within a 25-Mile Radius of DFAs in the Preferred Alternative

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Blackwater Fault		13.3
Bullion Fault		20.4
Calico Fault Zone		29.4
Coyote Creek Fault		29.6
Elsinore Fault Zone		16.8
Emerson Fault		30.3
Garlock Fault Zone	1.2	131.0
Gravel Hills - Harper Fault Zone		26.2
Helendale Fault	2.7	28.1
Johnson Valley Fault	1.5	36.2
Laguna Salada Fault Zone		19.7
Lenwood Fault	0.1	44.1
Lockhart Fault		3.9
Owens Valley Fault Zone		27.5
Panamint Valley Fault Zone		34.7
Pinto Mountain Fault		22.3
San Andreas Fault Zone	2.1	127.7
San Bernardino Fault		29.2
San Jacinto Fault Zone		53.9
West Calico Fault		21.0
White Wolf Fault		21.4
Grand Total	**7.6**	**766.4**

Source: USGS (2014b)

Volume III, Section III.4.4.4, describes the locations of recent volcanic activity. Within DFAs in the Preferred Alternative, there is less than one square mile of recent volcanic flow rocks. The likelihood of a renewable energy facility being located near an active volcanic site is so low that facility damage or threat to life is possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative (Appendix R2), shows the erosion potential of soil textures found in the DRECP area and acreage of soil textures with moderate to high potential for erosion found in DFAs in each alternative. Within DFAs in the Preferred Alternative, there are approximately 210,000 acres of soils with a moderate to high potential for wind erosion and approximately 107,000acres of soils with a moderate to high potential for water erosion. Development of renewable energy facilities within these areas of DFAs in the Preferred Alternative would increase the likelihood of soil erosion from wind and water.

Sand Transport. Under the Preferred Alternative, DFAs in the East Riverside region are on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor, which includes the Kelso Dunes, the Bristol Trough corridor, which includes the Cadiz and Danby dunes, the Rice Valley corridor, which includes the Rice Valley Dunes, and the Clark's Pass corridor, which includes the Dale Lake Dunes and Palen-Ford Dunes (USGS 2003). Renewable energy facilities in these DFAs could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Within DFAs in the Preferred Alternative, there are approximately 79,000 acres of dune systems and sand transport corridors.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2.1.2, Typical Impacts, corrosive soils could damage foundations and structural elements of renewable energy facilities. Expansive soils could cause soils to shrink or swell, damaging foundations and other structural elements. The Preferred Alternative includes approximately 16,000 acres of potentially expansive soils. See Table R2.4-3, Acreage of Expansive Soil Textures Within DFAs for Each Alternative (Appendix R2), which defines areas of clay, clay loam, silty clay, and silty clay loam. Corrosive soils are widespread throughout the DRECP area. Playas and North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially corrosive soil within the DRECP area. The Preferred Alternative includes approximately 18,000 acres of potentially corrosive soils within the DFAs.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities in the Preferred Alternative may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

Impacts on Variance Process Lands

Variance Process Lands are neither reserve lands nor DFAs. They are a subset of the variance lands identified in the Solar PEIS Record of Decision and additional lands that, based on current information, have moderate to low ecological value and ambiguous value for renewable energy. If renewable energy development occurs on Variance Process Lands, LUPA would not be required, so the environmental review process would be simpler than if the location were left as undesignated.

Variance Process Lands for each alternative are as shown in Chapter IV.1, Table IV.1-2, and in Volume II, Chapter II.3, Figure II.3-1 for the Preferred Alternative. Development of the Variance Process Lands would have similar air quality effects as described under Impacts SG-1 through SG-4.

Impact Reduction Strategies

Implementation of the Proposed LUPA would enhance conservation of many BLM-administered public lands, as well as the development of renewable energy generation and transmission facilities on other lands. The impacts of renewable energy development covered in the DRECP would be lessened in several ways. First, it incorporates Conservation and Management Actions (CMAs) for each alternative, including LUPA-wide CMAs and CMAs for specific land designations such as Natural Landscape Conservation System (NLCS) lands, ACECs, and wildlife allocations. Also, the implementation of existing laws, orders, regulations, and standards would reduce the impacts of project development.

Conservation and Management Actions

The conservation strategy for the Preferred Alternative (presented in Volume II, Section II.3.4) defines specific actions that would reduce the impacts of this alternative. The conservation strategy includes specific land designations and CMAs for the Preferred Alternative. This section presents summaries of relevant CMAs that would reduce impacts to geology and soils. The full text of all CMAs is presented in Section II.3.4.2.

CMAs for the Preferred Alternative for Geology and Soils

LUPA-SW-2: Buffer zones, setbacks, and activity limitations directly associated with soil and water resources, not including the biological associated or dependent resources will be determined on a site-specific basis, consistent with the LUPA protection goals for these resources. In general, placement of long-term facilities within buffers or protected zones will be discouraged.

LUPA-SW-8: As determined necessary on an activity specific basis, prepare a site plan specific to major soil types present (≥5% of footprint or laydown surfaces) in Wind Erodibility Groups 1 and 2 and in Hydrology Soil Class D as defined by the USDA Natural Resource Conservation Service to minimize water and air erosion from disturbed soils on activity sites.

LUPA-SW-9: The extent of desert pavement within the proposed boundary of an activity shall be mapped if it is anticipated that the activity may create erosional or ecologic impacts. Disturbance of desert pavement within the boundary of an activity shall be limited to the extent possible, and shall not exceed 10% of the desert pavement mapped within the activity boundary without BLM approval.

LUPA-SW-10: The extent of additional sensitive soil areas (cryptobiotic soil crusts, hydric soils, highly corrosive soils, expansive soils, and soils at severe risk of erosion) shall be mapped if it is anticipated that an activity will impact these resources. To the extent possible, avoid disturbance of desert biologically intact soil crusts, and soils highly susceptible to wind and water erosion.

Biological CMAs Relevant to Geology and Soils

LUPA-BIO-7: This CMA requires restoration of temporary disturbance areas, such as construction areas for pipelines and transmission, staging areas, and construction-related roads. Restoration activities include the restoration, reclamation, and revegetation of temporarily disturbed areas.

LUPA-BIO-8: General closure and decommissioning of activity sites must include appropriate restoration measures such as recontouring, the installation of erosion control measures, and the restoration of vegetation and soil profiles.

LUPA-BIO-9: The protection of water dependent species through this CMA would require implementation of activity specific drainage, erosion, and sedimentation control actions, the maintenance of natural drainages and hydrologic function, the reduction of impervious surfaces, the use of retention basins as appropriate. This CMA also requires the stabilization of disturbed areas, the minimization of wind and water erosion, and the maintenance of long-term erosion control measures.

LUPA-BIO-13: General siting and design criteria in this CMA would maximize the use of existing roads, routes, and utility corridors, and would minimize new disturbance areas.

LUPA-BIO-15: Use state-of-the-art construction and installation techniques that minimize new site disturbance, soil erosion and deposition, soil compaction, disturbance to topography, and removal of vegetation.

LUPA-BIO-DUNE-1: For activities that potentially occur within or bordering Aeolian and sand transport corridors, complete studies to verify the accuracy of the DRECP dunes and sand resources mapping, as shown in Appendix H, and to determine if a proposed activity would interfere with a sand transport corridor.

LUPA-BIO-DUNE-2: Activities that potentially affect the amount of sand entering or transported within Aeolian transport corridors will be designed and operated to minimize interference with these processes.

LUPA-BIO-DUNE-3: Any facilities or activities that alter site hydrology (e.g., sediment barrier) will be designed to maintain continued sediment transport and deposition in the Aeolian corridor in a way that maintains the Aeolian sorting and transport to downwind deposition zones. Site designs for maintaining this transport function must be approved by BLM in coordination with USFWS and CDFW as appropriate.

DFA-VPL-BIO-DUNE-2: Within Aeolian corridors that transport sand to dune formations and vegetation types downwind inside and outside of the DFAs, all activities will be designed and operated to facilitate the flow of sand across activity sites, and avoid the trapping or diverting of sand from the Aeolian corridor. Buildings and structures within the site will take into account the direction of sand flow and, to the extent feasible, build and align structures to allow sand to flow through the site unimpeded. Fences will be designed to allow sand to flow through and not be trapped.

Air Resources CMAs Relevant to Geology and Soils

LUPA-AIR-5: A fugitive Dust Control Plan will be developed for all projects where the NEPA analysis shows an impact to air quality from fugitive dust.

Laws and Regulations

Similar to the No Action Alternative, existing laws and regulations will reduce certain impacts of DRECP implementation. Relevant regulations are presented in the Regulatory

Setting in Volume III, Section III.4.1. The requirements of relevant laws and regulations are summarized for the No Action Alternative in Section IV.4.3.1.1.

IV.4.3.2.2 Impacts of Ecological and Cultural Conservation and Recreation Designations

The conservation designations included in the Preferred Alternative would total 4,926,000 acres (see Chapter IV.1, Table IV.1-1, Summary of Alternative Components). This would protect soil resources by limiting development within the DRECP area, which could also reduce potential effects from geologic hazards.

IV.4.3.2.3 Impacts of Transmission Outside the DRECP Area

The impacts of transmission outside of the DRECP area on geology and soils would be the same under all alternatives. These impacts are as described for the No Action Alternative in Section IV.4.3.1.3, Impacts of Transmission Outside the DRECP Area.

IV.4.3.2.4 Comparison of the Preferred Alternative With No Action Alternative

Under the No Action Alternative, development would continue under existing BLM land designations and protective requirements, including those of the Solar PEIS. Development would be more constrained under the Preferred Alternative because LUPA would encourage development within DFAs and prohibit development within expansive conservation areas. Therefore, potential impacts from soil erosion and loss of desert pavement would be more severe under the No Action Alternative.

Table IV.4-3 compares the Preferred Alternative with the No Action Alternative for each of the measurable factors in this analysis.

Table IV.4-3
Comparison of Preferred Alternative With No Action Alternative

Comparison Factor	Preferred Alternative	No Action Alternative
Miles of active fault lines within DFAs	10	90
Miles of active fault lines within 25 miles of DFA boundaries	800	800
Acres of soils with moderate-to-high potential for wind erosion	210,000	1,451,000
Acres of soils with moderate-to-high potential for water erosion	107,000	795,000
Acres of sand and sand transport corridors in DFAs	79,000	307,000

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals ; therefore, the subtotals may not sum to the total within the table.

Geographic Distinctions. Many impacts to geology and soils could occur throughout the DRECP area. In the Preferred Alternative, significant dune systems and sand transport corridors occur within DFAs in the East Riverside area, specifically along I-10. Active faults are concentrated primarily in DFAs in the Imperial Borrego Valley, West Mojave and Eastern Slopes, and Panamint Death Valley ecoregion subareas.

IV.4.3.3 Alternative 1

Alternative 1 includes 81,000 acres of total DFAs, approximately 7.6 million acres of existing conservation within the DRECP area, and approximately 4.9 million acres of BLM LUPA conservation designations.

Under Alternative 1, dispersed solar development is anticipated for the Cadiz Valley and Chocolate Mountains, Imperial Borrego Valley, Owens River Valley, Pinto Lucerne Valley and Eastern Slopes, and West Mojave and Eastern Slopes ecoregion subareas. Dispersed wind development is anticipated in the Cadiz Valley and Chocolate Mountains and the Pinto Lucerne Valley and Eastern Slopes ecoregion subareas. Dispersed geothermal development is anticipated in the Imperial Borrego Valley ecoregion subarea.

IV.4.3.3.1 Impacts of Renewable Energy and Transmission Development

Under Alternative 1, DFAs are primarily in the Cadiz Valley and Chocolate Mountains, Imperial Borrego Valley, Owens River Valley, and Pinto Lucerne Valley and Eastern Slopes ecoregion subareas. Impacts related to soils, geology, and geologic hazards would result from development of solar, wind, geothermal, and transmission facilities, both within and outside of DFAs.

The potential for soil erosion can be quantified based on acreage of erosive soils that may be disturbed during construction and decommissioning, as well as, to a lesser degree, during site characterization. The potential for impacts from geologic hazards can be quantified based on miles of active fault lines within 25 miles of DFAs in Alternative 1. Other geologic and soil impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed qualitatively.

Proposed BLM land use designations (e.g., National Conservation Lands, ACECs, wildlife allocations, and trail management corridors) would prohibit renewable energy development and be managed to protect ecological, historic, cultural, scenic, and scientific resources and values; this would additionally provide general protection for geologic and soil resources. Disturbance caps on National Conservation Lands and ACECs would provide further protections. ACECs would make up the majority of the proposed BLM land designations under Alternative 1.

Existing or expanded SRMAs would also prohibit surface-occupying renewable energy development, but could also conversely cause soil erosion from recreation uses, depending on the extent of allowable uses and management within specific SRMAs.

Impact SG-1: Expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active, with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, including the San Andreas and San Jacinto faults. During the life of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-4 shows major active faults, which the USGS defines as having ruptured within the Holocene (the past 11,000 years) (USGS 2014[a]).

For each fault, Table IV.4-4 shows its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. Under Alternative 1, 0.1 mile of active fault lines is within DFAs and 680.5 miles are outside DFAs but within the 25-mile buffer set for this fault analysis. See Volume III, Table III.4-2 for the earthquake magnitude potential for each of the listed faults and their associated Alquist-Priolo designations. The faults presented in Table IV.4-4 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied residential structures, damage to property could still be considerable.

Table IV.4-4
Faults Within a 25-Mile Radius of DFAs in Alternative 1

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Blackwater Fault		13.3
Bullion Fault		17.5
Calico Fault Zone		29.4
Coyote Creek Fault		29.6
Elsinore Fault Zone		16.8
Emerson Fault		30.3
Garlock Fault Zone	0.1	106.9
Gravel Hills - Harper Fault Zone		26.2
Helendale Fault		30.7
Johnson Valley Fault		37.6
Laguna Salada Fault Zone		19.7
Lenwood Fault		44.2
Lockhart Fault		3.9

Table IV.4-4
Faults Within a 25-Mile Radius of DFAs in Alternative 1

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Owens Valley Fault Zone		30.0
Pinto Mountain Fault		17.5
San Andreas Fault Zone		109.7
San Bernardino Fault		29.3
San Jacinto Fault Zone		56.5
West Calico Fault		21.0
White Wolf Fault		10.5
Grand Total	**0.1**	**680.5**

Source: USGS 2014b.

Volume III, Section III.4.4.4, describes the locations of recent volcanic activity. Within DFAs in Alternative 1, there is very little area of recent (Holocene) volcanic flow rocks. Developers would avoid locating renewable energy facilities near an active volcanic site, so facility damage or threat to life would be possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative, (Appendix R2) presents the erosion potential of soil textures found in the DRECP area and the acreage of soil textures with moderate to high potential for erosion in DFAs for each alternative. Within DFAs in Alternative 1, there are 44,000 acres of soils with a moderate to high potential for wind erosion and 41,000 acres of soils with a moderate to high potential for water erosion. Development of renewable energy facilities within these DFAs in Alternative 1 would increase the likelihood of soil erosion from wind and water.

Sand Transport. In Alternative 1, DFAs in the East Riverside region are on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor, which includes the Kelso Dunes, the Bristol Trough corridor, which includes the Cadiz and Danby dunes, the Rice Valley corridor, which includes the Rice Valley Dunes, and the Clark's Pass corridor, which includes the Dale Lake Dunes and Palen-Ford Dunes (USGS 2003). Renewable energy facilities in these DFAs could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Within DFAs in Alternative 1, there are approximately 15,000 acres of dune systems and sand transport corridors.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2.1, corrosive soils could damage foundations and other structural elements of renewable energy facilities. Expansive soils could cause soils to shrink or swell, also damaging foundations and structural elements. Alternative 1 includes 343,000acres of potentially expansive soils. See Table R2.4-3, Acreage of Expansive Soil Textures Within Developable Areas for Each Alternative (Appendix R2), which includes clay, clay loam, silty clay, and silty clay loam. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially corrosive soil within the DRECP area. Alternative 1 includes approximately 90 acres of potentially corrosive soils within DFAs.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities constructed in DFAs under Alternative 1 may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not yet been mapped would require field surveys.

Impacts on Variance Process Lands

Variance Process Lands are neither reserve lands nor DFAs. They are a subset of the variance lands identified in the Solar PEIS Record of Decision and additional lands that, based on current information, have moderate to low ecological value and ambiguous value for renewable energy. If renewable energy development is built on Variance Process Lands LUPA would not be required, so the environmental review process would be simpler than if the location were left as undesignated.

Variance Process Lands for each alternative are shown in Chapter IV.1, Table IV.1-2 and in Volume II, Chapter II.4, Figure II.4-1, for Alternative 1. Development of Variance Process Lands would have similar air quality effects as described under Impacts SG-1 through SG-4.

Impact Reduction Strategies

Implementation of the Proposed LUPA would result in new conservation designations for many acres of desert lands as well as for development of renewable energy generation and transmission on other lands. The impacts of this development would be lessened in several ways. First, LUPA incorporates CMAs for each alternative. The implementation of existing laws, orders, regulations, and standards would also reduce the impacts of project development.

Conservation and Management Actions

The CMAs for Alternative 1 (presented in Volume II, Section II.4.4) define specific actions that would reduce the impacts of this alternative. Section II.4.4.2, presents specific CMAs for Alternative 1. The CMAs in Alternative 1 that are relevant to geology and soils would be the same as the CMAs for the Preferred Alternative that are presented in Section IV.4.3.2.1, except as described below.

All of the CMAs that are described for the Preferred Alternative would apply to Alternative 1, with the following modifications for activities within DFAs:

- Limit disturbance of sensitive soil areas so that no more than 1% of sensitive soil areas within a proposed project footprint would be disturbed by construction.
- Exclude renewable energy development that would disturb sand dunes.
- Limit disturbance of sand flow corridors so that no more than 1% of sand flow corridors within a proposed project footprint would disturbed by construction.
- Limit disturbance of desert pavement so that no more than 5% of desert pavement within a proposed project footprint would be disturbed by construction.
- Avoid development in flood plains, unless its effects can be mitigated.
- Create a 0.25-mile protective offset around playas.

Laws and Regulations

As defined under the No Action Alternative, existing laws and regulations will reduce certain impacts of Plan implementation as summarized in Section IV.4.3.1.1. Relevant regulations are described in more detail in Volume III, Section III.4.1, Regulatory Setting.

IV.4.3.3.2 Impacts of Ecological and Cultural Conservation and Recreation Designations

The conservation designations proposed in Alternative 1 would total 4,863,000 acres (see Chapter IV.1, Table IV.1-1, Summary of Alternative Components). This would protect soil resources by limiting both development within the DRECP area and the amount of land available for development, which would also reduce potential geologic hazards.

IV.4.3.3.3 Impacts of Transmission Outside the DRECP Area

The impacts of transmission outside of the DRECP area on geology and soils would be the same under all alternatives. These impacts are as described for the No Action Alternative in Section IV.4.3.1.3, Impacts of Transmission Outside the DRECP Area.

IV.4.3.3.4 Comparison of Alternative 1 with Preferred Alternative

The impacts of renewable energy on BLM lands under LUPA for Alternative 1 would be less than under the Preferred Alternative. LUPA land designations under Alternative 1 would offer similar protection to soil resources as those under the Preferred Alternative; however, CMAs under Alternative 1 would have stricter limits on disturbance to sand flow corridors, desert pavements, and sensitive soils.

Table IV.4-5 compares Alternative 1 with the Preferred Alternative for each of the measurable factors included in this analysis.

Table IV.4-5
Comparison of Alternative 1 With the Preferred Alternative

Comparison Factor	Alternative 1	Preferred Alternative
Miles of active fault lines within DFAs	0	10
Miles of active fault lines within 25 miles of DFA boundaries	700	800
Acres of soils with moderate to high potential for wind erosion	44,000	210,000
Acres of soils with moderate to high potential for water erosion	41,000	107,000
Acres of sand and sand transport corridors in DFAs	15,000	79,000

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals ; therefore, the subtotals may not sum to the total within the table.

Geographic Distinctions. Many impacts related to geology and soils could occur throughout the DRECP area so are not useful in distinguishing one alternative from another. Under Alternative 1, there are fewer acres in DFAs in eastern Riverside County. Therefore, fewer areas of dune systems and sand transport corridors are within DFAs in this region. In this alternative, active faults are concentrated primarily in the DFAs within the West Mojave and Eastern Slopes ecoregion subarea.

IV.4.3.4 Alternative 2

Under Alternative 2, renewable energy projects would be encouraged within DFAs. Alternative 2 includes 718,000 acres of total DFAs, which is approximately 7.6 million acres of existing conservation within the DRECP area and approximately 5.2 million acres of BLM LUPA conservation designations. In Alternative 2, solar development is located primarily in the Cadiz Valley and Chocolate Mountains, Imperial Borrego Valley, and West Mojave and Eastern Slopes ecoregion subareas. Wind development is located primarily in the Cadiz Valley and Chocolate Mountains and Imperial Borrego Valley ecoregion subareas.

Dispersed geothermal development is anticipated in the Imperial Borrego Valley and the Owens River Valley ecoregion subareas.

IV.4.3.4.1 Impacts of Renewable Energy and Transmission Development

Under Alternative 2, DFAs are located primarily in the Cadiz Valley and Chocolate Mountains ecoregion subarea, the Imperial Borrego Valley ecoregion subarea, and the West Mojave and Eastern Slopes ecoregion subarea. Impacts to soils, geology, and geologic hazards would occur within the DRECP area from development of solar, wind, geothermal, and transmission facilities, both within and outside of DFAs.

The potential for soil erosion can be quantified based on acreage of erosive soils that may be disturbed during construction and decommissioning and, to a lesser degree, during site characterization. The potential for impacts from geologic hazards can be quantified based on miles of active fault lines within 25 miles of DFAs in Alternative 2. Other geologic and soil impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed qualitatively

Impact SG-1: Plan components would expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active, with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, including the San Andreas and San Jacinto faults. During the lifetime of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-6 shows major active faults, which the USGS defines as having ruptured within the Holocene (the past 11,000 years) (USGS 2014a). For each fault, Table IV.4-6 presents its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. In Alternative 2, 9.5 miles of active fault lines are within DFAs and 818.3 miles are outside of DFAs but within the 25-mile buffer set for this fault analysis. See Volume III, Table III.4-2, for the earthquake magnitude potential for each of the listed faults and associated Alquist-Priolo designations. The faults presented in Table IV.4-6 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied residential structures, damage to property could still be considerable.

Table IV.4-6
Faults Within a 25-Mile Radius of DFAs in Alternative 2

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Blackwater Fault		13.3
Bullion Fault		20.4
Calico Fault Zone		29.4
Coyote Creek Fault		29.6
Elsinore Fault Zone		16.8
Emerson Fault		30.3
Garlock Fault Zone	3.4	136.2
Gravel Hills - Harper Fault Zone		26.2
Helendale Fault	0.0	30.7
Johnson Valley Fault	1.9	35.8
Laguna Salada Fault Zone		19.7
Lenwood Fault	1.0	43.2
Lockhart Fault		3.9
Mill Creek Fault		22.9
Owens Valley Fault Zone	1.2	30.4
Panamint Valley Fault Zone		35.0
Pinto Mountain Fault		31.9
San Andreas Fault Zone	2.2	132.1
San Bernardino Fault		31.7
San Jacinto Fault Zone		56.5
West Calico Fault		21.0
White Wolf Fault		21.4
Grand Total	**9.5**	**818.3**

Source: USGS 2014b.

Volume III, Section III.4.4.4, describes the locations of recent volcanic activity. Within DFAs in Alternative 2, there is very little area of recent volcanic flow rocks. The likelihood of a renewable energy facility being located in the immediate area of an active volcanic site is low, so facility damage or threat to life is possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative (Appendix R2), presents the erosion potential of soil textures found in the DRECP area and acreage of soil textures with moderate to high potential for erosion found in DFAs in each alternative. On BLM-administered public lands in Alternative 2 there are approximately

420,000 acres of soils with a moderate to high potential for wind erosion and approximately 219,000 acres of soils with a moderate to high potential for water erosion. Development of renewable energy facilities within these areas of DFAs in Alternative 2 would increase the likelihood of soil erosion from wind and water.

Sand Transport. Under Alternative 2, development in the East Riverside region are either on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between the areas of Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor (including the Kelso Dunes), the Bristol Trough corridor (including the Cadiz and Danby dunes), the Rice Valley corridor (including the Rice Valley Dunes), and the Clark's Pass corridor (including the Dale Lake Dunes and Palen-Ford Dunes) (USGS 2003). Renewable energy facilities in these DFAs could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Within DFAs in Alternative 2, there are approximately 107,000 acres of dune systems and sand transport corridors.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2, Typical Impacts Common to All Action Alternatives, corrosive soils could damage foundations and structural elements of renewable energy facilities. Expansive soils could shrink or swell, also damaging foundations and structural elements. Alternative 2 includes approximately 29,000 acres of potentially expansive soils in DFAs. See Table R2.4-3, Acreage of Expansive Soil Textures Within DFAs for Each Alternative (Appendix R2), which includes clay, clay loam, silty clay, and silty clay loam. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially corrosive soil. Alternative 2 includes approximately 21,000 acres of potentially corrosive soils.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities constructed in DFAs in Alternative 2 may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

Impacts on Variance Process Lands

Variance Process Lands are neither reserve lands nor DFAs. They are a subset of the variance lands identified in the Solar PEIS Record of Decision and additional lands that, based on current information, have moderate to low ecological value and ambiguous value for renewable energy. If renewable energy development is built on Variance Process Lands, LUPA would not be required, so the environmental review process would be simpler than if the location were left as undesignated.

Variance Process Lands for each alternative are shown in Chapter IV.1, Table IV.1-2, and in Volume II, Chapter II.5, Figure II.5-1, for Alternative 2. Development of the Variance Process Lands would have similar air quality effects as described under Impacts SG-1 through SG-4.

Impact Reduction Strategies

Implementation of the Proposed LUPA would both conserve some desert lands and develop development renewable energy projects on other lands. The impacts of the renewable energy development covered under LUPA would be lessened in several ways. First, the DRECP incorporates CMAs for each alternative, including LUPA-wide CMAs and CMAs for specific land designations such as NLCS lands, ACECs, and wildlife allocations. Also, the implementation of existing laws, orders, regulations, and standards would reduce the impacts of project development.

Conservation and Management Actions

The conservation strategy for Alternative 2 (presented in Volume II, Section II.5.4) defines specific actions that would reduce the impacts of this alternative. Section II.5.4.2 presents specific CMAs for Alternative 2. The CMAs in Alternative 2 relevant to geology and soils would be the same as the CMAs for the Preferred Alternative presented in Section IV.4.3.2.1, except as described below.

Unlike the Preferred Alternative, this alternative would not implement CMA LUPA-BIO-13. All of the remaining CMAs described for the Preferred Alternative would apply as well to Alternative 2, with the following modifications for activities within DFAs:

- Limit disturbance of sensitive soil areas so that no more than 20% of the sensitive soil areas within a proposed project footprint would be disturbed by construction.
- Limit disturbance of sand dune areas so that no more than 5% of sand dune areas within a proposed project footprint would be disturbed by construction.
- Limit disturbance of sand flow corridors so that no more than 5% of sand flow corridors within a proposed project footprint would be disturbed by construction.
- Limit disturbance of desert pavement so that no more than 5% of desert pavement within a proposed project footprint would be disturbed by construction.

- Avoid development in a flood plain unless it can be mitigated.
  - **Exceptions:** Exceptions to any of these stipulations may be granted by the authorized officer if the operator submits a plan that demonstrates that:
    - The impacts from the proposed action are temporary.
    - The impacts are minimal or can be adequately mitigated.
    - Critical resources, including threatened and endangered species, are fully protected.
  - **Modifications:** No modifications will be granted.
  - **Waivers:** No waivers will be granted.

Biological and Air Resources CMAs relevant to geology and soils under the Preferred Alternative apply to Alternative 2 as well.

Laws and Regulations

Similar to the No Action Alternative, existing laws and regulations will reduce certain impacts of Plan implementation; they are summarized in Section IV.4.3.1.1. The requirements of relevant regulations are described in more detail in Volume III, Section III.4.1, Regulatory Setting.

IV.4.3.4.2 Impacts of Ecological and Cultural Conservation and Recreation Designations

The conservation designations under Alternative 2 would total 4,863,000 acres (see Chapter IV.1, Table IV.1-1, Summary of Alternative Components). This would protect soil resources by limiting both development within the DRECP area and the amount of developable land.

IV.4.3.4.3 Impacts of Transmission Outside the DRECP Area

The impacts of transmission outside of the DRECP area on geology and soils would be the same under all alternatives. These impacts are described for the No Action Alternative in Section IV.4.3.1.3, Impacts of Transmission Outside the DRECP Area.

IV.4.3.4.4 Comparison of Alternative 2 With Preferred Alternative

Table IV.4-7 compares Alternative 2 with the Preferred Alternative for each of the measurable factors included in this analysis.

Table IV.4-7
Comparison of Alternative 2 With the Preferred Alternative

Comparison Factor	Alternative 2	Preferred Alternative
Miles of active fault lines within DFAs	10	10
Miles of active fault lines within 25 miles of DFA boundaries	800	800
Acres of soils with moderate-to-high potential for wind erosion	420,000	210,000
Acres of soils with moderate-to-high potential for water erosion	219,000	107,000
Acres of sand and sand transport corridors in DFAs	107,000	79,000

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals ; therefore, the subtotals may not sum to the total within the table.

Geographic Distinctions. Many impacts related to geology and soils could occur throughout the DRECP area so it is not useful to distinguish one alternative from another. In Alternative 2, DFAs in the eastern Riverside County area are similar in size but slightly more extensive than DFAs in the Preferred Alternative. Significant dune systems and an important sand transport corridor are located within this area, specifically along I-10. In this alternative, active faults are concentrated in DFAs in the Mojave and Silurian Valley, Panamint Death Valley, West Mojave and Eastern Slopes, Pinto Lucerne Valley and Eastern Slopes, and Imperial Borrego Valley ecoregion subareas.

IV.4.3.5 Alternative 3

In Alternative 3, activities associated with solar, wind, and geothermal development and operation would be streamlined within DFAs. Alternative 3 includes 211,000 acres of total DFAs, approximately 7.6 million acres of existing conservation within the DRECP area, and approximately 5.0 million acres of BLM LUPA conservation designations.

In Alternative 3, dispersed solar development is anticipated for the West Mojave and Eastern Slopes ecoregion subarea, the Cadiz Valley and Chocolate Mountains ecoregion subarea, and the Imperial Borrego Valley ecoregion subarea. Dispersed wind development is anticipated in the Pinto Lucerne Valley and Eastern Slopes ecoregion subarea and the Cadiz Valley and Chocolate Mountains ecoregion subarea. Dispersed geothermal development is anticipated in the Imperial Borrego Valley and the Owens River Valley ecoregion subareas.

IV.4.3.5.1 Impacts of Renewable Energy and Transmission Development

Under Alternative 3, DFAs are located primarily in the Imperial Borrego Valley and Cadiz Valley and Chocolate Mountains ecoregion subareas. Impacts to soils, geology, and geologic hazards would occur within the DRECP area from development of solar, wind, and geothermal facilities.

The potential for soil erosion can be quantified based on acreage of erosive soils that may be disturbed during construction and decommissioning and, to a lesser degree, during site characterization. The potential for impacts from geologic hazards can be quantified based on miles of active fault lines within 25 miles of DFAs. Other soils and geologic impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed qualitatively.

Impact SG-1: Expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active, with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, including the San Andreas and San Jacinto faults. During the lifetime of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-8 shows major active faults, which the USGS defines as having ruptured within the Holocene (the past 11,000 years) (USGS 2014[a]).

For each fault, Table IV.4-8 shows its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. In Alternative 3, there are 3.4 miles of active fault lines within DFAs and 743.6 miles outside of DFAs but within the 25-mile buffer set for this fault analysis. See Table III.4-2, Largest Faults Within the DRECP Area, for the earthquake magnitude potential for each of the listed faults and their associated Alquist-Priolo designations. The faults presented in Table IV.4-8 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied residential structures, damage to property could still be considerable.

Table IV.4-8
Faults Within a 25-Mile Radius of DFAs in Alternative 3

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Blackwater Fault		13.3
Bullion Fault		20.4
Calico Fault Zone		29.4

Table IV.4-8
Faults Within a 25-Mile Radius of DFAs in Alternative 3

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Coyote Creek Fault		29.6
Elsinore Fault Zone		16.8
Emerson Fault		30.3
Garlock Fault Zone	1.2	125.5
Gravel Hills - Harper Fault Zone		26.2
Helendale Fault	0.0	30.7
Johnson Valley Fault		37.6
Laguna Salada Fault Zone		19.7
Lenwood Fault	0.1	44.1
Lockhart Fault		3.9
Owens Valley Fault Zone		31.5
Panamint Valley Fault Zone		34.7
Pinto Mountain Fault		21.7
San Andreas Fault Zone	2.2	116.2
San Bernardino Fault		29.3
San Jacinto Fault Zone		56.5
West Calico Fault		21.0
White Wolf Fault		5.2
Grand Total	**3.4**	**743.6**

Source: USGS 2014b.

Volume III, Section III.4.4.4, describes the locations of recent volcanic activity. Within DFAs in Alternative 3, there is very little area of recent volcanic flow rocks. The likelihood of a renewable energy developer locating a project near an active volcanic site is low, so facility damage or threat to life possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative (Appendix R2) show the erosion potential of soil textures and acreage of soil textures with moderate to high potential for erosion in DFAs for each alternative. Within DFAs on BLM-administered public lands in Alternative 3, there are approximately 130,000 acres of soils with moderate to high potential for wind erosion and approximately 88,000 acres of soils with moderate to high potential for water erosion. Development of renewable energy facilities within these areas of DFAs in Alternative 3 would increase the likelihood of soil erosion from wind and water.

Sand Transport. Under Alternative 3, DFAs in the East Riverside region are on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor, which includes the Kelso Dunes, the Bristol Trough corridor, which includes the Cadiz and Danby dunes, the Rice Valley corridor, which includes the Rice Valley Dunes, and the Clark's Pass corridor, which includes the Dale Lake Dunes and Palen-Ford Dunes (USGS 2003). Renewable energy facilities in these DFAs could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Within DFAs in Alternative 3, there are approximately 32,000 acres of dune systems and sand transport corridors.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2, Typical Impacts Common to All Action Alternatives, corrosive soils could damage foundations and structural elements of renewable energy facilities. Expansive soils could cause soils to shrink or swell, also damaging foundations and structural elements. Alternative 3 includes 15,000 acres of potentially expansive soils. See Table R2.4-3, Acreage of Expansive Soil Textures Within DFAs for Each Alternative (Appendix R2), which includes clay, clay loam, silty clay, and silty clay loam. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially corrosive soil. Alternative 3 includes approximately 15,000 acres of potentially corrosive soils within DFAs.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities in Alternative 3 may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

Impacts on Variance Process Lands

Variance Process Lands are neither reserve lands nor DFAs. They are a subset of the variance lands identified in the Solar PEIS Record of Decision and additional lands that, based on current information, have moderate to low ecological value and ambiguous value for renewable energy. If renewable energy development is built on Variance Process Lands, a LUPA would not be required, so the environmental review process would be simpler than if the location were left as undesignated.

Variance Process Lands for each alternative are shown in Chapter IV.1, Table IV.1-2, and in Volume II, Chapter II.6, Figure II.6-1, for Alternative 3. Development of Variance Process Lands would have similar air quality effects as described under Impacts SG-1 through SG-4.

Impact Reduction Strategies

Implementation of the Proposed LUPA would result in new conservation designations for some lands as well as the designation of areas for renewable energy generation and transmission facilities. The impacts of the renewable energy development covered by the LUPA would be lessened in several ways. First, the LUPA incorporates CMAs for each alternative, including LUPA-wide CMAs and CMAs for specific land designations, such as NLCS lands, ACECs, and wildlife allocations. Also, the implementation of existing laws, orders, regulations, and standards would reduce the impacts of project development.

Conservation and Management Actions

The conservation strategy for Alternative 3 (presented in Volume II, Section II.6.4) defines specific actions that would reduce the impacts of this alternative. Section II.6.4.2 presents specific CMAs for Alternative 3. The CMAs in Alternative 3 that are relevant to geology and soils would be the same as the CMAs for the Preferred Alternative that are presented in Section IV.4.3.2.1, except as described below.

All of the CMAs that are described for the Preferred Alternative would apply to Alternative 3, with the following modifications for activities within DFAs:

- Limit disturbance of sensitive soil areas so no more than 1% of the sensitive soil areas within a proposed project footprint shall be disturbed for construction.
- Exclude renewable energy development in sand dune areas.
- Limit disturbance of sand flow corridors so no more than 1% of the sand flow corridors within a proposed project footprint shall be disturbed for construction.
- Limit disturbance of desert pavement so no more than 5% of the desert pavement within a proposed project footprint shall be disturbed for construction.
- Avoid development in floodplains, unless such development can be mitigated.
- Apply a 0.25-mile protective offset around playas.

Biological and Air Resources CMAs relevant to geology and soils under the Preferred Alternative apply to Alternative 3 as well.

Laws and Regulations

As defined under the No Action Alternative, existing laws and regulations will reduce certain impacts DRECP implementation; they are summarized in Section IV.4.3.1.1. Relevant regulations are described in more detail in Section III.4.1, Regulatory Setting.

IV.4.3.5.2 Impacts of Ecological and Cultural Conservation and Recreation Designations

The conservation designations under Alternative 3 would total 5,023,000 acres (see Chapter IV.1, Table IV.1-1, Summary of Alternative Components). This would result in the protection of soil resources, due to the limitations on development within the DRECP area, and would limit the extent of land on which projects could be developed. This could reduce potential effects of geologic hazards.

IV.4.3.5.3 Impacts of Transmission Outside the DRECP Area

The impacts of transmission outside of the DRECP area on geology and soils would be the same under all alternatives. These impacts are as described for the No Action Alternative in Section IV.4.3.1.3, Impacts of Transmission Outside the DRECP Area.

IV.4.3.5.4 Comparison of Alternative 3 With Preferred Alternative

Table IV.4-9 compares Alternative 3 with the Preferred Alternative for each of the measurable factors included in this analysis.

Table IV.4-9
Comparison of Alternative 3 With the Preferred Alternative

Comparison Factor	Alternative 3	Preferred Alternative
Miles of active fault lines within DFAs	0	10
Miles of active fault lines within 25 miles of DFA boundaries	700	800
Acres of soils with moderate-to-high potential for wind erosion	130,000	210,000
Acres of soils with moderate-to-high potential for water erosion	88,000	107,000
Acres of sand and sand transport corridors in DFAs	32,000	79,000

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals; therefore, the subtotals may not sum to the total within the table.

Geographic Distinctions. Many impacts related to geology and soils could occur throughout the DRECP area, so are not useful in distinguishing one alternative from another. In Alternative 3, fewer DFA acres are in the eastern Riverside County region than in the Preferred Alternative, so potential effects to dunes and sand transport corridors in that area would be reduced. Active faults in Alternative 3 are concentrated primarily in DFAs in the Panamint Death Valley, West Mojave and Eastern Slopes, and Imperial Borrego Valley ecoregion subareas.

IV.4.3.6 Alternative 4

Under Alternative 4, activities associated with solar, wind, and geothermal development and operation would be permitted within DFAs. Alternative 4 includes 258,000 acres of total DFAs, approximately 7.6 million acres of existing conservation within the DRECP area, and approximately 4.4 million acres of BLM LUPA conservation designations. In Alternative 4, both dispersed solar and dispersed wind development are anticipated for the Cadiz Valley and Chocolate Mountains ecoregion subarea. Dispersed geothermal development is anticipated in the Imperial Borrego Valley and in the Owens River Valley ecoregion subareas.

Effects of Alternative 4 on geology and soils are described in the following sections. This discussion includes the effects of renewable energy development, including transmission development and other land use decisions within the LUPA Decision Area.

IV.4.3.6.1 Impacts of Renewable Energy and Transmission Development

Under Alternative 4, DFAs are located primarily in the Cadiz Valley and Chocolate Mountains ecoregion subarea and the Imperial Borrego Valley ecoregion subarea portions of the DRECP area. Impacts related to soils, geology, and geologic hazards would occur within the DRECP area from development of solar, wind, and geothermal facilities. Impacts would also occur from transmission development, both within and outside of the DFAs. The potential for soil erosion can be quantified based on acreage of erosive soils that may be disturbed during construction and decommissioning and, to a lesser degree, during site characterization. The potential for impacts from geologic hazards can be quantified based on miles of active fault lines within 25 miles of DFAs in Alternative 4. Other geologic and soil impacts such as disturbance to desert pavement and structural damage from expansive or corrosive soils are assessed qualitatively.

The BLM land use designations (e.g., National Conservation Lands, ACECs, wildlife allocations, and trail management corridors) would prohibit renewable energy development and be managed to protect ecological, historic, cultural, scenic, and scientific resources and values; these designations would also protect geologic and soil resources. Disturbance caps on National Conservation Lands and ACECs would provide further protections. A combination of National Conservation Lands and ACECs would make up the majority of the proposed BLM land designations under Alternative 4.

Existing or expanded SRMAs would also prohibit surface-occupying renewable energy development, but could conversely cause to soil erosion from recreation uses, depending on the extent of allowable uses and management within specific SRMAs.

Impact SG-1: Expose people or structures to injury or damage from seismic, volcanic, or landslide activity.

As described in Volume III, Section III.4.3, the DRECP area is seismically and volcanically active, with major fault lines, young volcanic features, and landslide sediment deposits. Within the DRECP area, major faults include some of the largest in the state, including the San Andreas and San Jacinto faults. During the lifetime of a renewable energy facility, earthquakes within the DRECP area are likely. Table IV.4-10, presents a selection of major active faults, which the USGS defines as having ruptured within the Holocene (the past 11,000 years) (USGS 2014[a]).

For each fault, Table IV.4-10 presents its length within the DFA boundary and its length outside the DFA but within 25 miles of the DFA boundary. In Alternative 4, 2.0 miles of active fault lines are within DFAs and 749.1 miles outside DFAs but within the 25-mile buffer set for this fault analysis. See Volume III, Table III.4-2, Largest Faults Within the DRECP Area, for the earthquake magnitude potential for each of the listed faults and their associated Alquist-Priolo designations. The faults shown in Table IV.4-10 represent a potential geologic hazard that could damage renewable energy facilities. While the majority of these facilities would not include occupied residential structures, damage to property could still be considerable.

Table IV.4-10
Faults Within a 25-Mile Radius of DFAs in Alternative 4

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
Blackwater Fault		13.3
Bullion Fault		15.7
Calico Fault Zone		29.4
Coyote Creek Fault		29.6
Elsinore Fault Zone		16.8
Emerson Fault		23.9
Garlock Fault Zone	1.2	127.4
Gravel Hills - Harper Fault Zone		26.2
Helendale Fault	0.8	29.9
Johnson Valley Fault		35.9
Laguna Salada Fault Zone		19.7
Lenwood Fault		44.2
Lockhart Fault		3.9
Owens Valley Fault Zone		30.0
Panamint Valley Fault Zone		35.0
Pinto Mountain Fault		10.1

Table IV.4-10
Faults Within a 25-Mile Radius of DFAs in Alternative 4

Fault Name	Length of Fault Within DFAs (miles)	Length of Fault Outside DFAs (miles)
San Andreas Fault Zone		129.8
San Bernardino Fault		29.3
San Jacinto Fault Zone		56.5
West Calico Fault		21.0
White Wolf Fault		21.4
Grand Total	**2.0**	**749.1**

Source: USGS 2014b.

Volume III, Section III.4.4.4, describes the locations of recent volcanic activity. Within DFAs in Alternative 4, there is very little area of recent volcanic flow rocks. The likelihood of a renewable energy facility being located near an active volcanic site is low, so facility damage or threat to life is possible but unlikely.

Impact SG-2: Trigger or accelerate soil or sand erosion.

Erosion. Table R2.4-2, Acreage of Erosive Soils Within DFAs for Each Alternative, (Appendix R2) presents erosion potential of soil textures found in the DRECP area and acreage of soil textures with moderate to high potential for erosion found in DFAs in each alternative. Within DFAs in Alternative 4, there are approximately 102,000 acres of soils with a moderate to high potential for wind erosion and approximately 51,000 acres of soils with a moderate to high potential for water erosion. Development of renewable energy facilities within these areas of DFAs in Alternative 4 would increase the likelihood of soil erosion from wind and water.

Sand Transport. Under Alternative 4, DFAs in the East Riverside region are either on or near an important sand transport corridor in the Chuckwalla Valley. The corridor runs parallel to I-10 in Riverside County between Desert Center and Blythe. Other sand transport corridors include the Mojave River corridor (including the Kelso Dunes), the Bristol Trough corridor (including the Cadiz and Danby dunes), the Rice Valley corridor (including the Rice Valley Dunes), and the Clark's Pass corridor (including the Dale Lake Dunes and Palen-Ford Dunes) (USGS 2003). Renewable energy facilities in these DFAs could impede sand transport and affect valuable habitat within this corridor of active sand dunes. Within DFAs in Alternative 4, there are 65,000 acres of dune systems and sand transport corridors.

Impact SG-3: Expose structures to damage from corrosive or expansive soils.

As stated in Section IV.4.2, Typical Impacts Common to All Alternatives, corrosive soils could damage foundations and structural elements of renewable energy facilities. Expansive soils could cause soils to shrink or swell, also damaging foundations and other structural elements. Alternative 4 includes approximately 3,000 acres of potentially expansive soils. See Table R2.4-3, Acreage of Expansive Soil Textures Within DFAs for Each Alternative (Appendix R2). Expansive soil textures include clay, clay loam, silty clay, and silty clay loam. Playas, North American warm desert alkaline scrub, herb playa, and wet flat all indicate potentially corrosive soil. Alternative 4 includes 10,000 acres of potentially corrosive soils within DFAs.

Impact SG-4: Destroy or disturb desert pavement.

Renewable energy facilities constructed in DFAs in Alternative 4 may damage desert pavement. Excavation and grading during construction and decommissioning, as well as ground disturbance from workers, vehicles, and equipment, would damage or disturb this important habitat. Specific locations of desert pavement that have not been mapped would require field surveys.

Impacts on Variance Process Lands

Variance Process Lands are neither reserve lands nor DFAs. They are a subset of the variance lands identified in the Solar PEIS Record of Decision and additional lands that, based on current information, have moderate to low ecological value and ambiguous value for renewable energy. If renewable energy development occurs on Variance Process Lands, LUPA would not be required, so the environmental review process would be simpler than if the location were left as undesignated.

Variance Process Lands for each alternative are as shown in Chapter IV.1, Table IV.1-2, and in Volume II, Chapter II.7, Figure II.7-1 for Alternative 4. Development of Variance Process Lands would have similar air quality effects as described under Impacts SG-1 through SG-4.

Impact Reduction Strategies

Implementation of the Proposed LUPA would create both additional conservation designations for some desert lands and designate other areas for streamlined renewable energy development. The impacts of renewable energy development within DFAs would be lessened in several ways. First, it incorporates CMAs for each alternative, including LUPA-wide CMAs and CMAs for specific land designations, such as NLCS lands, ACECs, and wildlife allocations. Implementation of existing laws, orders, regulations, and standards would also reduce the impacts of project development.

Conservation and Management Actions

The conservation strategy for Alternative 4 (presented in Volume II, Section II.7.4) defines specific actions that would reduce the impacts of this alternative. Section II.7.4.2 presents specific CMAs for Alternative 4. The CMAs in Alternative 4 that are relevant to geology and soils would be the same as the CMAs for the Preferred Alternative that are shown in Section IV.4.3.2.1, except as described below.

All of the CMAs described for the Preferred Alternative would apply to Alternative 4, with the following modifications for activities within DFAs:

- Limit disturbance of sensitive soil areas, so no more than 20% of the sensitive soil areas within a proposed project footprint would be disturbed by construction.
- Limit disturbance of sand dunes, so no more than 5% of the sand dunes within a proposed project footprint would be disturbed by construction.
- Limit disturbance of sand flow corridors, so no more than 5% of the sand flow corridors within a proposed project footprint would be disturbed by construction.
- Limit disturbance of desert pavement, so no more than 5% of the desert pavement within a proposed project footprint would be disturbed by construction.
- Avoid development in floodplains unless it can be mitigated.
    - **Exceptions:** Exceptions to any of these stipulations may be granted by the authorized officer if the operator submits a plan that demonstrates that:
        - The impacts from the proposed action are temporary.
        - The impacts are minimal or can be adequately mitigated.
        - Critical resources, including threatened and endangered species, are fully protected.
    - **Modifications:** No modifications will be granted.
    - **Waivers:** No waivers will be granted.

Biological and Air Resources CMAs relevant to geology and soils under the Preferred Alternative apply to Alternative 4 as well.

Laws and Regulations

As defined under the No Action Alternative, existing laws and regulations will reduce certain impacts of LUPA implementation; they are summarized in Section IV.4.3.1.1. Relevant regulations are described in more detail in Volume III, Section III.4.1, Regulatory Setting.

IV.4.3.6.2 Impacts of Ecological and Cultural Conservation and Recreation Designations

The conservation designations under Alternative 4 would total 4,431,000 acres (see Chapter IV.1, Table IV.1-1, Summary of Alternative Components). This would result in the protection of soil resources by limiting development within the DRECP area and the available land on which projects could be developed. This could reduce potential geologic hazards.

IV.4.3.6.3 Impacts of Transmission Outside the DRECP Area

The impacts of transmission outside of the DRECP area on geology and soils would be the same under all alternatives. These impacts are as described for the No Action Alternative in Section IV.4.3.1.3, Impacts of Transmission Outside the DRECP Area.

IV.4.3.6.4 Comparison of Alternative 4 With Preferred Alternative

Table IV.4-11 compares Alternative 4 with the Preferred Alternative for each of the measurable factors included in this analysis.

Table IV.4-11
Comparison of Alternative 4 With the Preferred Alternative

Comparison Factor	Alternative 4	Preferred Alternative
Miles of active fault lines within DFAs	2.0	7.6
Miles of active fault lines within 25 miles of DFA boundaries	749.1	766.4
Acres of soils with moderate-to-high potential for wind erosion	102,000	210,000
Acres of soils with moderate-to-high potential for water erosion	51,000	107,000
Acres of sand and sand transport corridors in DFAs	65,000	79,000

Note: The following general rounding rules were applied to calculated values: values greater than 1,000 were rounded to the nearest 1,000; values less than 1,000 and greater than 100 were rounded to the nearest 100; values of 100 or less were rounded to the nearest 10, and therefore totals may not sum due to rounding. In cases where subtotals are provided, the subtotals and the totals are individually rounded. The totals are not a sum of the rounded subtotals ; therefore, the subtotals may not sum to the total within the table.

Geographic Distinctions. Many impacts related to geology and soils could occur throughout the DRECP area, so are not useful in distinguishing one alternative from another. In Alternative 4, the DFA in the eastern Riverside County region is similar to that of the Preferred Alternative. These significant dune and sand transport corridors that would be affected by development are located along I-10. In this alternative, active faults are concentrated in DFAs in the Panamint Death Valley and West Mojave and Eastern Slopes ecoregion subareas.